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were, as already stated, nearly identical in the two situations, with a preponderance of coloring in favor of the outside. I was thus forced, though reluctantly, to dismiss all the experiments thus far made as having yielded doubtful results, excepting those made in the propagating house, of which it will be necessary to speak further.[1]

How can we account for the results in this situation differing from those of the other rooms? I was unable at that time to find any good reason, the conditions appearing to be about the same. Subsequent experimentation, however, threw new light upon this vexed question. It will be only necessary here to state, what I trust will be evident to the mind of the reader later on, that the somewhat more striking results in this house must have been due to the fact that it was well stocked with flowering geraniums.

(To be continued.)

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THE CREODONTA.

BY E. D. COPE.

(Continued from the March number, p. 267.)

HYÆNODONTIDÆ.

In this family the anterior cusp of the inferior true molars is so developed as to form, with the median cusp, a true sectorial blade. The posterior cusp is rudimental, and in the last inferior molar wanting. There is no internal tubercle. In the superior molars, on the contrary, the anterior basal cusp has disappeared, and the posterior one is developed behind the middle one, like a blade. The superior molars, like the inferior, have no internal lobe.

Professor W. B. Scott has studied the posterior limb and the brain-case of a species of Hyænodon, which he describes as follows. I quote from the advance sheets of his paper on this subject, which he has kindly permitted me to use:

"The hind limb is in essentials very like that of Mesonyx of the Bridger Eocene; the femur has a decided third trochanter. The tibia is much like that of Mesonyx, and its distal end is characteristically Creodont in having its astragalus face almost flat, with only a very slight median ridge for the groove of the astragalus. The internal malleolus is very large.

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[1] My acknowledgments are due Mr. Menje for valuable assistance while conducting these observations.

" The astragalus is but slightly concave from side to side, much less so than in Mesonyx.

" The foot is plantigrade, and the entire length of the calcaneum rested on the ground. Five well-developed digits were present, terminating in short and stout compressed claws; very different from the peculiar depressed ungual phalanges of Mesonyx; otherwise the resemblance of the foot as a whole to that of Mesonyx is very striking.

" The brain case attributed by Gervais to Hyænodon must belong to some other genus, or else our American species differ very radically from the French. In the American species the brain is relatively very small and simple, being but slightly larger than that of Thylacynus, to which animal Hyænodon presents many interesting approximations in the structure of the skull and teeth. The cerebellum of Hyænodon is entirely uncovered by the hemispheres, which in their turn seem to have but three straight longitudinal gyri, presenting the simplest type of the carnivorous brain."

It is highly probable that this family is a derivative of a pentadactyl form of the Mesonychidæ. Its appearance in time corresponds nearly with the disappearance of the latter.

But one genus of this family has been thus far described, the Hyænodon of Laizer and Parieu. Its dental formula is I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{3}{4}$; M. $\frac{3}{3}$. The last three molars in both jaws are sectorials, and the last of these are the largest, and form the most effective shears for the dividing of animal tissues. The position of these teeth indicates a mouth fissured far posteriorly, and a correspondingly posterior position of the masseter muscle. This structure indicates a weak power of prehension of the canine teeth. This character is sustained by the frequently anteriorly directed inferior canines, and the generally slender mandibular rami. The Hyænodons must be regarded as snappers, and not capable of holding on to a living enemy with much persistency.[1] They were evidently weaker in all points of organism than the modern Carnivora, which no doubt accounts for their extinction. Thirteen species have been described, all but three North American forms being French. The oldest of these, the *H. parisiensis* Kefst., is from the Upper Eocene or Oligocene, or the Paris Gypsum, but its reference to this genus is not yet certain. Gaudry, however, states that Hyænodon occurs in the Gypse. Seven species are described by Filhol as from the Phosphorites. Some of these (as *H. leptorhynchus* L. & P.) are elsewhere found in the Stampian, a Lower Miocene, but some of them are probably Upper Eocene.[1] The three North American species are from the White

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[1] See On the origin of the sectorial tooth of the Carnivora, AMERICAN NATURALIST, 1876, p. 171.

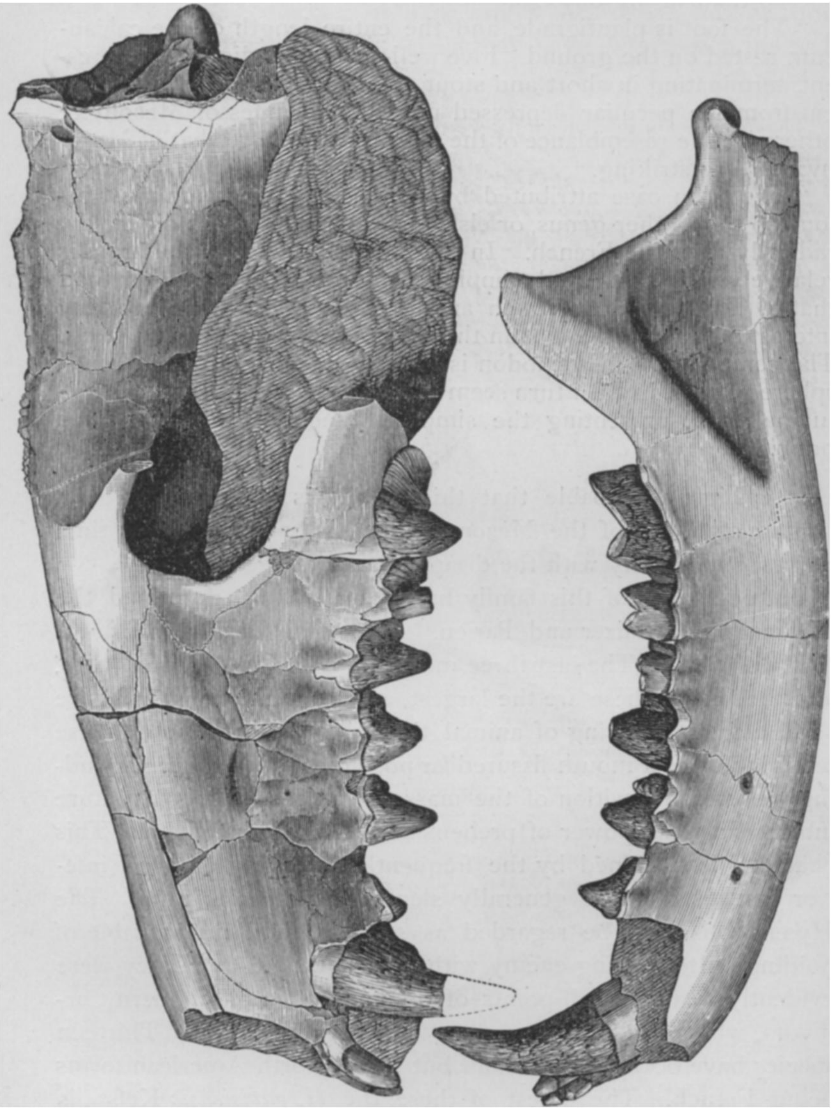

FIG. 12.—*Hyænodon horridus* Leidy, skull one-half natural size. From the White River formation of Nebraska. From Leidy's Extinct Mammalia of Dakota and Nebraska.

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[1] Professor Gaudry thinks the Phosphorites include fossils of different Tertiary epochs.

River or Oligocene horizon, and no species is known from later formations. The species range in size from that of the *H. vulpinus* Gerv., which equals a red fox, to that of an American black bear, as the *H. heberti* Filhol, and *H. horridus* Leidy (Fig. 12). The latter species is from the bad lands of Nebraska.

LEPTICTIDÆ.[1]

This family is very nearly related to the Centetidæ, which are now living in Madagascar. The only character by which I distinguish it is by the presence of the zygomatic arch, a part of the skull which is absent in the Centetidæ (Fig. 13). The Leptictidæ

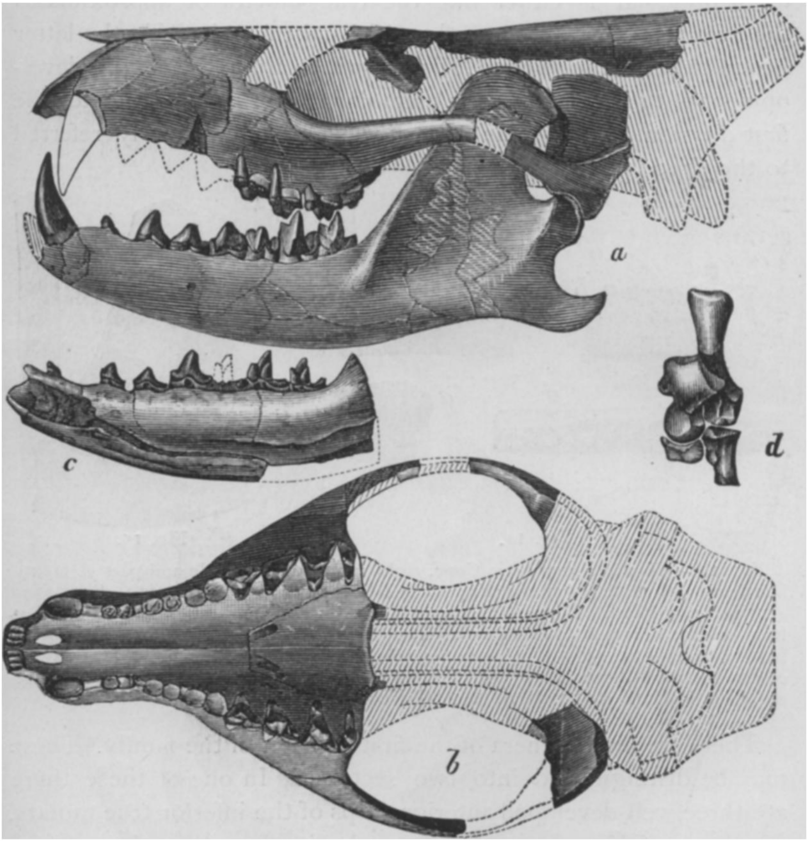

FIG. 13.—*Stypolophus whitiæ* Cope, skull and part of posterior foot of two individuals, two-thirds natural size. Figs. *a–b* from the Wasatch beds of the Big Horn river, Wyo. Figs. *c–d* from the basin of the Wind river, Wyo. Fig. *c*, internal side of part of right mandibular ramus. Fig. *d*, left tarsus minus cuneiform bones, from above. Original, from Vol. III, Report U. S. Geological Survey Terrs., F. V. Hayden.

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[1] This family is included in the Centetidæ in the first part of this paper, p. 261.

are no doubt the ancestors of the Centetidæ; and their later types, as Leptictis, approach the existing family in their dentition quite closely.[1] The earlier types display great variety in their dentition, and give ground for distinguishing many genera.

Two groups are easily recognized among the Leptictidæ. In the first of these the last or fourth inferior premolar is a simple premolariform tooth, different from the inferior true molars, and without any internal cusp. In the second division the fourth inferior premolar is either like the true molars or approximates their form by the presence of an internal tubercle. To the latter group belongs the genus Chriacus, which from the slight development of the fourth inferior premolar (Fig. 14) approximates the first division. The genus may, however, be improperly referred to the Creodonta.

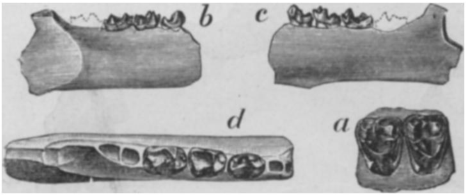

Fig. 14.

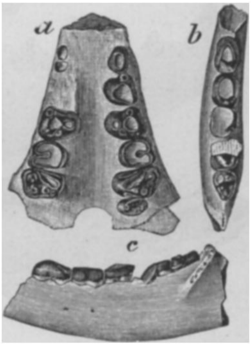

Fig. 15.

FIG. 14.—*Chriacus angulatus* Cope, right ramus of mandible and part of maxillary bone with teeth; from the Wasatch beds of the Big Horn, Wyoming. Figs. *a* and *d* twice natural size. Figs. *b–c* natural size. Fig. *a*, first and second true molars from below; *b*, ramus from external side; *c*, the same, internal side; *d*, the same from above. FIG. 15.—*Mioclænus turgidus* Cope, part of skull and lower jaw of one animal, two-thirds natural size. From the Puerco beds of New Mexico. Original, from Vol. III, Report U. S. Geol. Survey Terrs.

There are seven genera of the first division of the family. These may be distinguished into two sections. In one of these there are three well-developed anterior cusps of the inferior true molars, forming a tubercular sectorial tooth; in the other the anterior cusp is rudimental or wanting, and the tooth approximates more or less the quadrituberculate condition. In the latter subsection there are three genera. The first of these, Mioclænus Cope, has the inferior true molars quadrituberculate and of equal elevation; the first true molar may have an anterior or fifth tubercle. The external cusps of the superior true molars are distinct and conical. In Triïsodon Cope, the inferior true molars only are known. These have four cusps with a rudimental anterior fifth. They differ from the corresponding cusps in all the other genera in being compressed so as to have fore and aft cutting edges. Diacodon Cope, is the third genus. Its superior molars are like those of Mioclænus, but the two anterior cusps of the lower true molars are much elevated, the posterior are rudimental, and there is a rudimental fifth in front.

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[1] Enough is now known of the mammalian fauna of Madagascar to convince us of its decidedly Miocene and, to some degree, Eocene character. The lemurs and Centetidæ approximate nearly the Eocene types; the Chiromys is near the Eocene Tillodonta, while the closest allies of the carnivorous genus Cryptoprocta are found in the Lower Miocene of France and the Middle Miocene of Oregon. The Oligocene descendants of the Eocene types appear to have persisted in Madagascar. The reptiles are not African but are South American.

Mioclænus presents the only truly quadritubercular lower molars in the suborder. It is so far known only from the Puerco or oldest Eocene of North America. There are nine species known so far, which range from the size of a mink (*M. minimus*) to that of a wolf (*M. ferox*) in the sizes of their jaws, but in the case of the *M. ferox*, of which a good deal of the skeleton is known, the body was relatively smaller. The species differ in the form of the third superior premolar, and in the robustness of their inferior premolars. The *M. turgidus* (Fig. 15) represents the type with robust premolars, and the *M. subtrigonus* (Fig. 17) those with more compressed premolars.

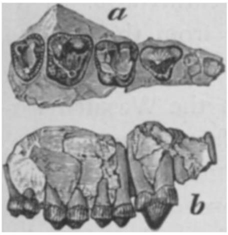

Fig. 16.

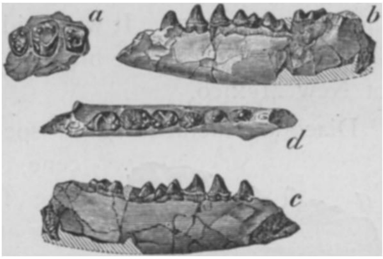

Fig. 17.

FIG. 16.—*Mioclænus corrugatus* Cope, last four molars on maxillary bone from below, two-thirds natural size. From the Puerco beds of New Mexico. Fig. *a*, from below; *b*, from right side. FIG. 17.—*Mioclænus subtrigonus* Cope, parts of maxillary and mandibular bones two-thirds natural size; from the Puerco beds of New Mexico; *a*, superior true molar teeth from below; *b*, left mandibular ramus, external side; *c*, do. inner side; *d*, from above. From Report U. S. Geol. Survey Terrs., Vol. III.

We can read the nature of the primitive mammal, *Mioclænus ferox*, in so far as the materials permit. It was an effective flesh-eater, and probably an eater of other things than flesh. It had a long tail and well-developed limbs. It had five toes all around, and the great or first toe was not opposable to the others, and may have been rudimental. The feet were plantigrade and the claws prehensile. The fore feet were well turned outwards. There were, perhaps, marsupial bones, but this point is not yet certainly determined. The presence of a patella distinguishes it from marsupials in general. Its embracing glenoid cavity of the skull, and form of the inferior molars, resemble those of the Arctocyonidæ.

This species is about the size of a sheep. The bones are stated by Mr. Baldwin, who discovered it, to be derived from the red beds in the upper part of the Puerco series.

The genus Triïsodon includes as yet but one species, the *T. quivirensis* Cope, which is only known from the rami of the lower jaw. These bones are shorter and more robust than those of the coyote, and indicate an animal of perhaps the size of the wolverine (Fig. 1, p. 257). It was evidently strongly carnivorous in its diet, and was a capable biter. Its remains are from the Puerco of New Mexico.

Diacodon includes seven species, two from the Wasatch Eocene, the others from the Puerco. The former are much the smaller (Fig. 18), while those of the Puerco vary in dimensions from the size of a common weasel (*D. assurgens*) to that of a wolf (*D. conidens*). The five species of the Puerco were formerly referred by me to the genus Triïsodon, but are now more properly placed in Diacodon. The only species in which the superior molars are known is the *D. conidens*, where they are generally identical with those of Mioclænus.

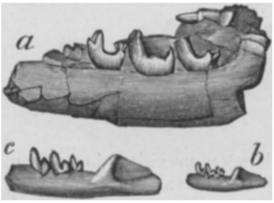

FIG. 18.—Jaws of species of Diacodon from the Wasatch bed of New Mexico. Fig. *a*, *Diacodon alticuspis* Cope, right mandibular ramus, inner side, twice natural size. Fig. *b*, *D. celatus*, left mandibular ramus, natural size; *c*, same, twice natural size. Original, from the Report U. S. G. G. Surv. W. of 100th mer., G. M. Wheeler.

Of the four genera of the first division of the Leptictidæ, which possesses tubercular sectorial teeth, but two are found in North America, while three of them have been discovered in Europe.

The typical and most widely distributed genus is Stypolophus

Cope (Fig. 13). It has compressed premolars, except the fourth superior, which is conic with two basal lobes. In Proviverra Rütimeyer, this tooth is triangular and cutting. One species has been found in the Swiss Eocene. Quercitherium of Filhol is distinguished by its very robust premolars. Like Proviverra it has but one rather small species. It is from the French Phosphorites. Stypolophus has the two cusps of the superior true molars close together, forming twin cusps, and they have behind them a heel, which is cutting. Two species have been discovered in the French Phosphorites, one of which, the *S. caylusi* of Filhol, is preserved to us in the most perfect skull of a Creodont known. From it I have restored the skull of the *S. whitiæ* (Fig. 13). It has elevated sagittal and posterior crests for the insertion of the temporal muscles, and the brain-case is very small. A cast of the brain displayed to Mr. Filhol the following characters: The hemispheres are small, and leave the cerebellum and the posterior edge of the middle brain uncovered. Anteriorly they contract to an isthmus which separates them from the large olfactory lobes. The hemispheres display three longitudinal convolutions, and very little indication of sylvian fissure. Of the American species, five are known from the Wasatch, and four from the Bridger beds.

Nearly allied to Stypolophus is the genus Didelphodus Cope, which only differs from it in the possession of but three superior premolars. The single species, *D. absarokæ* Cope, is about the size of a skunk, and has been obtained in the Wasatch Eocene beds of the Big Horn river, Wyoming (Fig. 19).

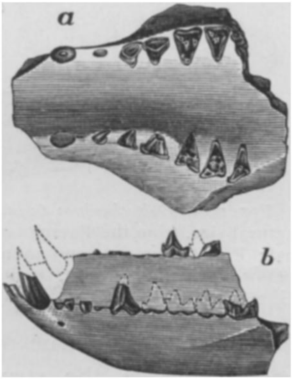

FIG. 19.—*Didelphodus absarokæ* Cope, muzzle and corresponding part of mandible of one individual, natural size. Original, from Vol. III, Report U. S. Geol. Surv. Terrs.

There are six genera of the second section of the family Leptictidæ, *i. e.*, those with the fourth inferior premolar more or less like the true molars. In five of these genera the canines and incisors have the proportions usual in carnivorous animals, but in the sixth, Esthonyx Cope, the canines are smaller than some of the incisors. In this respect Esthonyx esembles some of the genera of

Centetidæ, and other recent families both of Creodonta and Insectivora (Fig. 23). Of the genera with large canines, Chriacus has already been mentioned as having a simple fourth premolar with only an internal cusp to distinguish it from the genera of Sect. I of the family. Its true lower molars have an anterior V of three connected cusps. This is also the character of the inferior molars and fourth premolar of Deltatherium (Fig. 20), which is also peculiar in having but $\frac{3}{3}$ premolars, and a diastema. In the three genera which remain, the anterior or fifth cusp of the true molars is rudimental. They differ from each other in the structure of the third superior premolar. In Ictops Leidy, this tooth has two external and one internal cusps; in Mesodectes Cope, there are one external and one internal cusps, and Leptictis Leidy, there is no internal cusp, and the external one is simple.

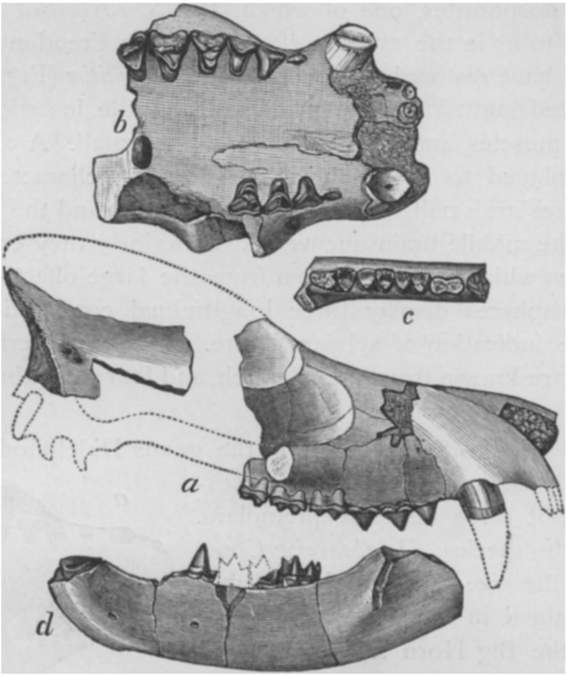

FIG. 20.—*Deltatherium fundaminis* Cope, skull and ramus mandibuli, two-thirds natural size, from the Puerco beds of New Mexico. Figs. *a b c* from one individual; Fig. *d* from a second animal. Fig. *a*, right side of cranium; *b*, palate, from below; *c*, mandible, part, from above; *d*, left ramus, outer side. From the Report U. S. Geol. Survey Terrs., Vol. III. Original.

There are certainly three, and probably four, species of Chriacus. The typical and largest species, *C. pelvidens* Cope, is from the Puerco Eocene of New Mexico; the smallest species, *C. angulatus* Cope, is from the Wasatch beds of New Mexico and Wyoming (Fig. 14). Perhaps it is near this genus that Tricentes Cope, should be placed. The latter only differs from Chriacus in the possession of but three superior premolars.[1] I have suspected that it belongs near Microsyops and Mixodectes in the Lemuroid series. There are three species, none larger than a skunk. The type, *T. crassicollidens,* is known from parts of two crania. The *T. inæquidens* was not larger than a gray squirrel.

The *Deltatherium fundaminis* Cope (Fig. 20), is one-half larger than the Virginian opossum, and much more robust. Its molar teeth are very opossum-like, while its canine teeth are relatively larger and stouter. The crowns of the canines are especially effective as weapons, from their vertical direction and form, their sharp anterior and posterior cutting edges, and their sides grooved like many blood-letting instruments. The sagittal crest is high, and the muzzle is short and wide, so that a decidedly bull-dog expression belonged to this animal. It is the most specialized form of the family and of the Puerco epoch, and was one of the most abundant. There are two other less known species of Deltatherium.

(To be continued.)

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ANATOMY AND PHYSIOLOGY OF THE FAMILY NEPIDÆ.

BY WILLIAM A. LOCY.

(Continued from page 255.)

The Salivary Glands.—The most anterior appendages to the alimentary canal are the salivary glands. These are especially well developed in the Hemiptera, and secrete a juice which doubtless aids in the digestion of food. The Nepidæ have four glands in two pairs, each pair consisting of a small gland and a large one, which open by ducts near the commencement of the œsophagus. The large glands, which are about five times the length of the small ones, extend back to the first abdominal segment, and are there united to the stomach by threads of tracheæ. At the anterior ends of the large glands are two round pouches, which probably serve for the storage of small quantities of saliva.

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[1] See Proceeds. American Philosoph. Society, 1883, p. 315.